# Thurlby PL Series

# Power Supplies

INSTRUCTION MANUAL

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## 1. INTRODUCTION

This instruction manual covers the full range of precision laboratory bench power supplies, single, dual and triple output models.

These units are variable DC ⎓ power supplies capable of operation in both constant voltage and constant current mode. Special features include simultaneous digital metering of voltage and current, provision for remote sensing, and a unique facility for setting the current level as well as the voltage prior to connection of the load.

Quad-Mode Dual units incorporate switching that provides four separate modes of operation; isolated, parallel, series and series tracking. K units incorporates two fully variable supplies plus a 5 volt high current supply to give three independent outputs.

## 2. AC~ LINE CONNECTION Read this first

(1) The transformer primary taps must be set within ± 10% of the nominal AC line voltage used. The voltage is indicated on a label near the power lead entry point. If alteration of the voltage setting is necessary, the cover must be removed and the taps changed as per section 3.

(2) The AC fuse is located on the back panel. Fuse ratings are given in the specification section.

(3) The AC input lead should be connected to a suitable 3 pin plug as follows: brown to live, blue to neutral, green/yellow to earth (ground).

(4) Incorrect connection of the AC input lead, or failure to connect to a supply earth can be dangerous.

(5) The unit is switched on by operating the switch marked~. Illumination of the L.E.D. displays indicates that the unit is on.

## 3. ADJUSTING THE AC~ LINE VOLTAGE SETTING

If it is necessary to alter the AC line voltage setting, this must be done by disconnecting the unit from the AC supply, removing the cover, and changing the transformer primary taps.

| These are clearly marked | A | B |
|---|---|---|
| | 0-110-120 | 0-110-120 |

Setting is as follows:-

| | |
|---|---|
| 240V operation: | Neutral (blue) wire to AO |
| | Link (red) wire from A120 to BO |
| | Live (brown) wire to B120 |
| 220V operation: | Neutral (blue) wire to AO |
| | Link (red) wire from A110 to BO |
| | Live (brown) wire to B110 |
| 120V operation: | Neutral (blue) wire to AO |
| | Link (black) wire from AO to BO |
| | Link (red) wire from A120 to B120 |
| | Live (brown) wire to B120 |
| 110V operation: | Neutral (blue) wire to AO |
| | Link (black) wire from AO to BO |
| | Link (red) wire from A110 to B110 |
| | Live (brown) wire to B110 |

Note: Units factory set to 220 or 240V will have no black link wire - this must be provided when converting to 110/120V operation. When converting a 110/120V unit to 220/240V the black link wire should be discarded.

**Important Note:** IEC 348 Safety Regulations state that the AC line voltage to which the apparatus is set must be clearly marked on the outside. If the line voltage setting is changed, it is imperative that the voltage marked on the label close to the power lead entry point is erased and the new setting voltage marked clearly in its place.

## 4. OPERATING INSTRUCTIONS – SINGLE SUPPLIES

### 4.1 Setting up the Output

The DC ⎓ supply is connected to the output terminals by the right hand switch marked ⎓. With this in the 'off' position, the voltage and current levels may be accurately set prior to connection to the load. The left hand meter indicates voltage, whilst the right hand meter indicates current.

With the output switch in the 'off' (set) position, the current meter shows the value of the current limit setting (indicated by all the decimal points coming on), whilst with the output switch 'on', it shows the value of load current flowing.

Unless remote sensing is required (see Section 4.7), the shorting bars should be placed from + sense to + output and from – sense to – output. **Ensure that the terminals are properly tightened before use.**

### 4.2 Constant Voltage

The voltage output is set using the coarse and fine voltage controls, the current control sets the maximum current that can be supplied.

### 4.3 Constant Current

If the load resistance is low enough such that, at the set level of output voltage, a current greater than the current limit setting would flow, the supply will automatically move into constant current operation.

The current output is set using the current limit control, the voltage controls set the maximum voltage that can be generated.

### 4.4 Constant Current Indication

When the unit is operating in constant current mode, either by intention or because the current limit point has been reached, the decimal points on the current meter will flash to indicate constant current rather than constant voltage operation.

### 4.5 Connection to the Load

The load should be connected to the positive (red) and negative (black) terminals marked 'output'. Both are fully floating and either can be connected to ground. The negative terminals are permanently connected to the power supply output, whilst the positive ones are connected through the output switch. The green terminal is connected to chassis and to the earth (ground) of the AC input cable. Either output terminal can be raised up to 300V above true ground - see electrical safety section.

### 4.6 Instantaneous Current Output

The current limit control can be set to limit the continuous output current to levels down to 1mA. However, in common with all precision bench power supplies, a capacitor is connected across the output (isolated by the output switch) to maintain stability and good transient response. This capacitor charges to the output voltage, and short circuiting of the output will produce a short current pulse as the capacitor discharges which is independent of the current limit setting.

### 4.7 Remote Sensing

The unit has a very low output impedance, but this is inevitably increased by the resistance of the connecting leads. At high currents, this can result in significant differences between the indicated source voltage and the actual load voltage. (Two 50mΩ connecting leads will drop 0.2V at 2 amps, for instance). This problem can be minimised by using short, thick, connecting leads, but where necessary it can be completely overcome by using the remote sense facility.

This requires the sense terminals to be connected to the output at the load instead of at the source. To avoid instability and transient response problems, care must be taken to ensure good coupling between each output and sense lead. This can be done either by twisting the leads together, or by using coaxially screened cable (sense through the inner). An electrolytic capacitor directly across the load connection point may also be beneficial.

The voltage drop in each output lead must not exceed 0.5 volts.

**4.8 Current Meter Damping**

The digital meters have a reading rate of about four readings per second (as fast as the eye can follow) and a damping time constant of 20msecs., thus providing virtually instantaneous response to reading changes.

If the unit is used to supply a load varying at a rate faster than about 0.5Hz, difficulty may be experienced in interpreting the current meter readings. This problem can be alieviated by turning on the switch marked 'damping'. This increases the current meter damping time constant to 2 seconds with the result that the meter will tend to read the average current flowing rather than following the variations. This facility should only be used when necessary since it greatly increases settling time and reduces absolute accuracy.

**4.9 Series or Parallel connection with other units**

The unit can be connected in series or parallel with others to produce higher voltages (maximum 300 volts) or higher current outputs.

It should be noted that the unit can only source current and cannot sink it, thus units cannot be series connected in anti-phase. Where several units are connected in parallel, the output voltage will be equal to that of the unit with the highest output voltage setting until the current drawn exceeds its current limit setting, upon which the output will fall to that of the next highest setting, and so on.

In constant current mode, units can be connected in parallel to provide a current equal to the sum of the current limit settings.

**4.10 Application of an external voltage source to the output.**

In common with all series regulated single ended power supplies, the unit is not capable of sinking current provided from an external source. If a voltage greater than the set output voltage of the unit is applied from an external source, the internal regulator will turn off, no current will flow, and the voltage meter will read the applied voltage. No damage will result providing the applied voltage does not exceed 50 volts. Application of voltage greater than this is prohibited.

If a reverse voltage is applied, this will be clamped by an internal reverse protection diode. The reverse current should not exceed 1 amp.

## 5. ADDITIONAL INSTRUCTIONS FOR QUAD-MODE DUAL VERSIONS

Quad-Mode Dual versions of the power supplies incorporate a bank of four interlocked push-button switches which enable any one of four different modes of operation to be selected. These are as follows:-

**(1) Isolated**

Each power supply operates as a completely separate and independent unit, electrically isolated from the other.

**(2) Parallel**

The output from both units is channelled into the Master unit (right hand side), increasing its current output capability accordingly. The Master unit then behaves exactly as a single power supply of increased current capability. The Slave unit (left hand side) becomes inoperative.

**(3) Series**

Operation is as in Isolated mode, except that the Slave positive output terminal is internally connected to the Master negative output terminal.

**(4) Tracking**

Operation is as for Series mode, except that the Master voltage controls operate on the Master and Slave units simultaneously. Thus voltages between 0 and 60V or 0 and ± 30V can be set up using only one control. The current limit controls on each unit continue to operate individually. Tracking accuracy is better than ± 0.3% of setting ± 0.1% of full range.

The Slave output switch should always be on. Both outputs are then switched from the Master output switch.

Remote sensing cannot be used in either Series or Tracking modes, therefore the shorting bars should be left in place.

Note 1: In order to avoid errors in Slave unit voltage meter reading when using Tracking mode, the Slave coarse voltage control should be turned to maximum.

Note 2: The Slave AC~ switch controls both supplies.

## 6. ADDITIONAL INSTRUCTIONS FOR TRIPLE OUTPUT (K) VERSIONS

These power supplies incorporate one single supply (instructions as per Section 4) occupying the right hand side of the unit, and a twin output K module occupying the left hand side, the instructions for which are given below.

### 6.1 0 to 30 Volt Supply

This supply occupies the right hand side of the module, although the AC switch is common to both supplies. Output voltage is variable between 0 and 30 volts and the current limit is fixed at 0.55A or 1.1A depending on model. An LED indicator shows when the current limit has been reached. No metering is provided for this output, although the meters fitted to the other supplies can be used as monitors - see Section 6.6.

With the right hand switch set in the 'Isolated' position, the output is fully isolated and floating, with the voltage being set via the calibrated control.

With the right hand switch set in the 'Tracking' position, the positive output terminal is internally linked to the negative of the single supply, and the supply becomes a series tracking slave to the single supply, enabling voltages between ± 0 to ± 30V to be provided, or a total voltage of 0 to 60V. The calibrated control becomes inoperative and should be set to maximum.

### 6.2 5V ± 1V Supply

This supply occupies the left hand half of the module. Output voltage is variable between 4V and 6V via a calibrated control, and the current limit is fixed at about 3.6A or 7.2A depending on model. Below 4 volts the current limit folds back so that short circuit current is reduced by a factor of around three. When the current limit is reached, indication is given by flashing decimal points on the current meter display. The digital meter monitors the output current flowing, and is fitted with a damping switch for use with rapidly varying loads.

### 6.3 Overvoltage Protection

This is fitted to the 5 volt supply in order to protect logic circuitry connected to it from damage during fault conditions. It consists of a thyristor which crowbars the rail voltage when a predetermined threshold has been exceeded. This threshold is user-adjustable between about 5.25V and 8.5V and has a built-in delay to prevent it from being fired by short-term transients. Transients in excess of 10 volts will fire the crowbar instantaneously, however.

Operation of the overvoltage protection is indicated by permanent illumination of all the decimal points. Once fired, the circuit can only be reset by reducing the crowbar current to zero. This can be done either by short-circuiting the output, or by turning the supply off briefly.

The unit is supplied with the O.V.P. set to about 6.25 volts. To reset it, place a screwdriver into the hole marked 'Set OVP' and rotate it fully anti-clockwise. Apply a voltage equal to the desired O.V.P. trip voltage to the output and rotate the control slowly clockwise until the crowbar fires, then stop.

### 6.4 Remote Sense

In order to eliminate connecting lead resistance effects at high currents, remote sense is provided on the 5 volt supply. When remote sense is required, the shorting links should be removed and the sense terminals connected to the output at the load end by additional wires. In order to maintain a satisfactory transient response, it is essential that an electrolytic capacitor of at least 220μF is fitted across the output at the junction of the output and sense leads.

### 6.5 Combining of Outputs

All three supplies are fully floating and feature automatic crossover into constant current mode when the current limit point is reached. Because of this, they may be safely combined with each other, or with external supplies, in parallel or series mode, to provide higher currents or higher voltages.

### 6.6 Monitoring of Outputs

When the single unit is not being used, its voltmeter can be used to monitor or set up a precise voltage on either of the module outputs. The single unit output should be set one to two volts below the voltage it is required to monitor, and should then be connected in parallel with that voltage. With the output switch on, the voltmeter will then give a precise reading of the voltage on the other output.

When the 5 volt output is not being used, it can be wired in series with the module 0 to 30 volt supply to give a 4V to 36V output with built-in current meter.

## 7. GENERAL SAFETY CONSIDERATIONS

The unit generates considerable heat and requires a full air cooling flow for correct operation. Do not obstruct any of the cooling slots in the cover, or block the inflow of air at the bottom.

Avoid allowing the unit to get damp, and keep away from corrosive fluids.

When supplying high currents at low voltages, the rear mounted heatsink becomes very hot. Although the heatsink is mounted behind a protective cover, care should be taken to avoid touching it at its base.

Do not remove the cover or any other part of the unit unless the plug has been removed from the AC∿supply.

Test, repair or set-up should only be conducted by skilled engineers conversant with the hazards of working with AC line powered equipment.

Read the electrical safety section at the rear.

## 8. CALIBRATION

The equipment is so designed and constructed that re-calibration should be required only infrequently. The Manufacturers will provide a re-calibration service, as will their agents overseas. Where owners wish to carry out re-calibration themselves, this should only be done by skilled personnel with access to precision equipment working in conjunction with the service manual which may be purchased directly from the Manufacturers or their agents overseas.

## 9. MAINTENANCE AND REPAIR

The Manufacturers or their agents overseas will provide repair for any unit developing a fault. Where owners wish to undertake their own maintenance work, this should only be done by skilled personnel in conjunction with the service manual which may be purchased directly from the Manufacturers or their agents overseas.

In the U.K., defective instruments should be returned, carriage paid, to the Manufacturers' Service Department. Careful and substantial packing is essential - no responsibility can be accepted for damage caused in transit - if possible, retain the original packing material. If the guarantee has expired or if the fault is the result of misuse, the repair will be carried out and charged unless other instructions are received.

Customers outside the U.K. should contact the dealer from whom the unit was purchased to ascertain service arrangements for that country.

## 10. TECHNICAL SPECIFICATION: SINGLE SUPPLIES

| | |
|---|---|
| Line Voltage: | 110, 120, 220, 240V AC ± 10% at 48-63Hz. |
| Output: | 0 to 31 volts 0 to 31 volts or 0 to 15.5V nominal<br>0 to 1.1A 0 to 1.1A or 0 to 2.2A or 0 to 3.98A nominal |
| Output Terminations: | 4mm terminals on 19mm (¾") spacing<br>DC output switch. |
| Sensing: | Remote via 4mm terminals or Direct via<br>shorting links (provided). |
| Line Stability: | <0.01% of maximum output for 10% line change. |
| Load Regulation: | <0.01% of maximum output for 50% load change. |
| Protection: | Full short circuit and overload protection. |
| Ripple and Noise: | <1mV typically. |
| Output Impedance: | <5mΩ at 1kHz. |
| Temperature Coefficient: | <0.01%°C typically. |
| Transient Response: | <20μsecs to <50mV of setting for 100% load change. |
| Constant Current<br>Output Impedance: | 50kΩ typically with voltage limit at maximum. |
| Voltage Controls: | Continuously variable by coarse and fine controls. |
| Current Limit: | Continuously variable from 0 to 110% of maximum<br>current rating. (0 to 99% 15V/4A units )<br>Automatic indication of constant<br>current operation. |
| Meters: | Dual 3¾ digit (4000 count) with 12.5mm (½")<br>LEDs. Reading rate 4 per second. |
| Meter Resolution: | Voltage 0.01 volts over entire range. Current<br>0.001 amps over entire range. |
| Meter Accuracy:<br>20°C to 25°C | Voltage 0.1% reading ± 0.05% full scale.<br>Current 0.3% reading ± 0.2 % full scale (0.5% reading<br>on 15V/4A units) |
| Current Meter Damping: | Normally 20msec switchable to 2 secs for<br>averaging of rapidly varying loads. |
| Operating Temperature<br>Range: | 0° to 45°C |
| Electrical Safety: | Designed and manufactured to comply with IEC 348. |

## TECHNICAL SPECIFICATION: K MODULES

**Output A: 5V ± 1V** fully floating, 3.5 amps or 7.0 amps

| | |
|---|---|
| Voltage Control: | Via calibrated control. |
| Current Limit: | Foldback current limit with automatic indication. |
| Current Metering: | 3¾ digit (4000 count) with 12.5mm LEDs.<br>Reading rate 4 per second. Switchable damping. |
| Overvoltage Crowbar: | Dual Speed. User adjustable trip point.<br>10msec at +5%, 1μsec at +100%. |
| Sensing: | Remote via 4mm terminals or Direct via<br>shorting links (provided). |

**Output B: 0 to 30V** fully floating or tracking, 0.5 amps or 1.0 amps

| | |
|---|---|
| Voltage Control: | Via calibrated control, or tracking with single<br>supply. |
| Current Limit: | Fixed at 110% of rated output LED overcurrent<br>indication. |

*Note: The manufacturers maintain a policy of continuous improvement and development and reserve the right to alter specifications without prior notice.*

| Fuse Ratings:- | (anti-surge type) | 220/240V | 110/120V |
|---|---|---|---|
| | Single supplies | 1A | 2A |
| | Dual and Triple Supplies | 2A | 3A |

## 11. GUARANTEE

The period and terms of the guarantee vary depending upon the country in which the unit was sold. Details of the product guarantee will be either included on a separate card, or available on request from the dealer from whom the unit was purchased.

## 12. SAFETY REGULATIONS IN ACCORDANCE WITH IEC 348

(1) This apparatus is safety class I by IEC classification.

The apparatus has been designed in accordance with IEC Publication 348 Safety Requirements for Electronic Test and Measuring Apparatus. This manual contains information and warnings which shall be followed by the user to ensure safe operation and to retain the apparatus in safe condition.

(2) Before connecting the apparatus, make sure that it is set to the voltage of the AC~ line supply. Use only the correctly rated fuses as specified. On no account use mended fuses or short-circuited fuseholders.

(3) If the unit is to be connected to the main supply by fixed wiring, rather than via an AC line plug, then the protective earth (ground) wire in the 3 core mains lead shall be connected to a protective conductor before any other connection is made.

(4) Ensure that an appropriate AC line plug is correctly connected to the captive 3 core cable provided with the unit.

Connections are:- brown = live, green/yellow = earth and blue = neutral. Ensure that the AC line socket to be used has a correctly connected protective earth (ground) contact. Do not use extension cords without protective earth conductors.

If the unit is to be used with live measuring or load circuits which have protective earth terminals, ensure that all protective earth terminals are connected to a protective conductor prior to switching on (the green front panel terminal may be used for this purpose).

If the unit is to be used with live measuring or load circuits which do not have protective earth terminals, ensure that the unit AC line plug is inserted before making connections between the unit output terminals and such circuits.

(5) Disconnection of the protective earth (ground) connection, or interruption of protective conductors is liable to render the apparatus dangerous. Intentional interruption is prohibited.

(6) The output of the power supply unit is fully floating and it may be used in series with other power supply units to generate high DC voltages up to 300V DC. Such voltages are exceedingly hazardous and great care should be taken to shield the output terminals for such use. On no account should the output terminals be touched when the unit is switched on under such use. All connections to the terminals must be made with the power switched off on all units.

(7) The apparatus must be disconnected from the AC line supply before the cover is removed for any purpose - otherwise dangerous voltages are accessible. Switching off by the front panel~ on/off switch is not sufficient.

The apparatus should not be re-connected to the AC line supply until the cover is replaced unless essential for purposes of repair or set-up. Therefore, such work should only be carried out by skilled persons aware of the hazards involved and working in conjunction with manufacturer's service information.

(8) If the apparatus is clearly defective, has been subject to mechanical damage, excess moisture, or chemical corrosion, the safety protection may be impaired and the apparatus should be withdrawn from use and returned for checking and repair.

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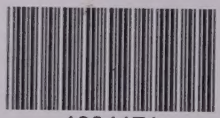

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